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Factors Associated With Readmission Of Patients With Congenital Heart Disease In A Swiss University Hospital

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TABLE DES MATIÈRES

ABSTRACT

Background: Congenital heart defects (CHD) are a common congenital anomaly that leads to extensive use of healthcare resources, yet there is little information available on the rates of readmission or the factors that predispose to readmission within 30 days of discharge. We sought to evaluate the rate of readmission among patients with CHD and to analyse the factors associated with readmission

Methods: Retrospective study using data concerning all patients with an ICD-10 code from Q20 to Q25 hospitalised between 2002 and 2014 at the University Hospital of Lausanne. Readmission and association with socio-clinical factors were evaluated for all non-humanitarian patients under the age of 18.

Results: 996 patients younger than 18 were hospitalised for CHD, 332 undergoing surgery. 96 patients (9.6%) were readmitted within 30 days of discharge, 83 (86.5%) cardiac causes. Median time to readmission was 10 days (interquartile range: 6 - 20) and median length of readmission was 12 days (interquartile range: 6 – 20). Foreign nationality, greater distance to hospital, and length of index hospitalisation < 14 days predisposed to readmission. Patients who underwent surgery were less likely to be readmitted (8.7%).

Conclusion: Readmissions were frequent, almost 1 in 10 patients, and associated with several socio-clinical factors. Providing patients who live far from hospital with specialized care closer to home may help reduce the rate of readmission.

Keywords: Congenital heart disease; readmission; Switzerland.

INTRODUCTION

Congenital heart disease (CHD) is the most common form of congenital anomaly, with a live birth prevalence ranging from 5 (1,2) to over 50 per 1'000 live births (2,3), with a slight decrease in Europe (4). Currently, 90% of children with CHD survive to adulthood (5), leading to rapid changes in the population of patients with CHD (6,7). Patients with CHD tend to use a lot of medical resources (8–10), which in turn puts pressure on the healthcare system, especially in a time where healthcare professionals are asked to control costs, all the while maintaining high quality of care. Different methods have been used to try to assess the latter, and hospital readmission rates are now widely cited as a surrogate measure not only of the quality of care, but also of the associated costs (11).

Studies have shown that close to 7% of children are readmitted to hospital within 30 days of discharge (12). Although some studies have concentrated specifically on children with asthma (13), a chronic health condition just as CHD is, few studies have been conducted on readmission rates among CHD patients (14–17), and none of them took place in Europe.

In Switzerland, the number of CHD adult patients has been estimated at 32'000 (18), although no specific study has ever been conducted, and the rate of readmission to hospital of CHD patients has never been evaluated.

Thus, our objectives were 1) to evaluate the rate of readmission among patients with CHD and 2) to analyse the factors associated with readmission.

MATERIALS AND METHODS

Data collection

The study was approved by the *Commision cantonale d'éthique de la recherche sur l'être humain* (protocol number 32/14; decision issued January 30th, 2014). No informed individual consent was necessary as the study used only available administrative data.

All hospitalizations with an international classification of diseases (ICD-10) code ranging from Q20 to Q25 recorded between the 1st of January 2002 and 30th of March 2014 at the CHUV were considered. The exact list of the ICD-10 codes included is provided in **Supplementary Table 1.** The CHUV is large hospital with over 1,200 beds dedicated to the care of patients living in the canton of Vaud and neighbour cantons. The CHUV has a unit specialized in paediatric CHD, and performs approximately 200 surgeries per year on CHDs. As the patients could attend the CHUV for a reason unrelated to their CHD (i.e. diarrhoea), only admissions and visits which main cause was an ICD-10 code corresponding to a CHD were included in the final sample.

Extracted data included gender, age at examination, country of birth, canton of residence and all other disease codes.

Statistical analysis

Statistical analyses were performed using Stata version 12.0 for windows (Stata Corp, College Station, Texas, USA). Descriptive results were expressed as number of participants (percentage) or as average ± standard deviation. Bivariate analyses were performed using chi-square or Fisher's exact test for qualitative variables and Student's t-test, analysis of variance or Kruskall-Wallis test for continuous variables. Multivariate analysis was performed using logistic regression and the results were expressed as Odds ratio (OR) and 95% confidence interval (CI). Tests were two-tailed and statistical significance was assessed for $p<0.05$.

RESULTS

Comparison between excluded and included patients

The exclusion criteria and the number of patients excluded are summarized in figure 1. Among children (<18 years), the comparison between humanitarian and non-humanitarian patients is summarized in **supplemental table 2**. There were fewer girls in the humanitarian patients than in the non-humanitarian patients. Humanitarian patients were on average older than non-humanitarian patients, with a mean age of 5.2 years (± 3.7), whereas the mean age of the non-humanitarian group was 2.7 years (± 4.4). A vast majority (94.2%) of the children admitted through humanitarian aid programs are older than one year of age, whereas a majority of non-humanitarian patients were less than one year old (61.8%). The distribution of CHD was also significantly different between humanitarian and non-humanitarian patients, with a greater proportion of patients presenting with a congenital malformation of cardiac septa (which includes the tetralogy of Fallot) in the humanitarian group (70.1% vs 53.3% among non humanitarian patients). There were however considerably more patients presenting with congenital malformations of great arteries (which includes patent ductus arteriosus, coarctation of the aorta, and arterial stenosis) in the non-humanitarian group (20.6% vs 7.9% among the humanitarian patients). All these factors led us to exclude the humanitarian patients from the study, as the distribution of disease and the characteristics of the population are so different from the rest of the study population, largely due to the fact humanitarian patients form a selected population which includes severe CHD that cannot be surgically corrected in their home countries but have allowed the patients to survive several years before they could be brought to Switzerland for treatment.

Factors associated with readmission, all patients

Among 996 hospitalizations, there were 96 (9.6%) readmissions within 30 days, 83 of which (86.5% of readmissions, 8.3% of all hospitalisations) with a cardiac diagnosis. Median time to

readmission was 10 days (interquartile range: 6 - 20) and median length of readmission was 12 days (interquartile range: 6 – 20).

The association between readmission at 30 days and different socio-clinical factors is summarized in table 2. Men seem to be slightly more likely to be readmitted (56.6% of patients readmitted for any cause were male), whether for cardiac causes or not, but the different rates of readmission were not significant. Likewise, younger patients had a trend towards more readmission (57.3% of the patients readmitted for a cardiac cause were younger then one), but once again the differences between rates of readmission were not significant. Non-Swiss patients were more likely to be readmitted than Swiss patients, 57.8% of the patients readmitted for cardiac causes having a nationality other than Swiss. The difference was not significant when the analysis included all causes of readmission instead of only cardiac ones. Patients with malformation of cardiac septa seem to have a higher rate of readmission than all other types of CHD, especially when patients were readmitted for cardiac causes (10.9% of patients with malformation of cardiac septa were readmitted to hospital under a cardiopathy diagnosis within 30 days of discharge, 11.7% were readmitted to hospital if all causes of readmission are included). Patients who lived far from the CHUV had a much higher rate of readmission: 15.1% were readmitted within 30 days, all causes included, whereas only 8.2% of patients living in the canton of Vaud were readmitted. Most of the patients readmitted had not had surgery (8.7% of surgical patients were readmitted vs 10.1% of non-surgical patients), but the difference was not significant. Patients with an initial hospital stay of less than 14 days had a lower rate of readmission for cardiac causes (4.1% of them were readmitted to hospital, whereas 9.7% of patients with an initial hospital stay of more than 14 days were readmitted). The difference was not significant if all causes of readmission were examined. Interestingly, most of the patients readmitted to hospital for any cause had been discharged at the beginning of a week (i.e. Monday or Tuesday discharge).

Multivariate analysis of the factors associated with readmission was conducted using logistic regression and including year of hospitalization, gender, age (over or below one year), surgery (yes/no), LOS>14 days (yes/no), canton of residence (Vaud, neighbor, distant), and day of discharge in the model. Living in a distant canton seems to be associated with a higher odds of readmission for cardiopathy: OR=3.15, 95% confidence interval [1.67; 5.93] (p for trend<0.001), while surgery and LOS>14 days were associated with a lower odds of readmission: 0.47 [0.24; 0.94] (p=0.032) and 0.45 [0.21; 0.97] (p=0.042), respectively. For re-hospitalisation for any cause, only living in a distant canton showed higher odds of readmission: 2.47 [1.35; 4.52] (p for trend=0.003). No association was found between re-hospitalisation and year of hospitalisation, gender, age group, type of cardiopathy, or day of discharge (not shown).

Factors associated with readmission, only surgical patients

The association between readmission at 30 days and different socio-clinical factors of the patients who underwent heart surgery is summarized in table 3. No association was found between re-hospitalisation at 30 days and all socio-clinical variables studied. Similarly, multivariate analysis showed no significant association between readmission and all socio-clinical variables studied (not shown).

DISCUSSION

Bias introduced by humanitarian patients

Humanitarian patients were excluded from this study as they introduced an important selection bias. The characteristics of this patient population were vastly different from the characteristics of the non-humanitarian patients, largely due to the fact humanitarian patients are selected according to specific criteria, among which we find severity of the disease and impossibility to correct the CHD in their home country.

Comparison to other studies

The rate of readmission in our study was 9.6% if all non-humanitarian patients were included (whether they had undergone surgery or not) and if all causes for readmission were included. This is slightly lower than all results found in literature, with readmission rates ranging from 10.5% (16) to 14.1% (17). Among surgical patients only, the readmission rate was of 8.7% in our study, which is even lower, even if compared only to the studies that excluded all non-surgical patients (i.e. Kogon et al (15), Saharan et al (14), Smith et al (16)).

The median time to readmission was 10 days in our study, which is comparable to findings in other studies, with median time to readmission ranging from 7 days (14) to 12 days (17).

The vast majority of the patients of our study (86.5%) were readmitted on basis of a cardiac diagnosis, which is considerably higher than what we have found in literature, although there were great disparities among the different studies, with numbers ranging from 14.9% (15) to 58.7% (17). Among surgical patients, 75.9% of the readmissions were caused by a cardiac diagnosis, sill considerably higher than the numbers cited in studies including only surgical patients (14–16).

In our study, surgery had a slight protective effect, which is consistent with the literature, studies conducted on this subject usually pointing toward a protective effect of surgery (15,17).

We have found foreign nationality to be associated with a higher risk of readmission, in line with Kogon et al (15) who have found Hispanic ethnicity to be associated with readmission.

There is no consensus in literature regarding risk of readmission associated with day of discharge, some studies citing a higher risk for end-of-week discharges (17), others citing higher risk associated with weekday discharges (16), others claiming that the only factor consistently associated with readmission is the severity of disease, not the day of discharge (19). In our study, we have found beginning of week discharges to be associated with a higher risk of readmission, although this was not statistically significant.

One of the most notable findings of our study involves the link between length of stay during index hospitalisation and risk of readmission. All studies conducted on the subject found that an initial hospital stay of more than 10 days was associated with a higher risk of readmission (14–17), which is the complete opposite of what we have found, where length of stay of more than 14 days was a protective factor for readmission. This could possibly be explained by a certain reluctance among pediatricians to discharge children at the end of a week after an index hospitalisation for CHD, thus artificially lengthening the index stay and possibly giving the hospital staff and parents more time to prepare for discharge.

The other notable finding of our study concerns distance to hospital, with a risk of readmission much higher for patients who live far from hospital than for those who live in the canton of Vaud. This could in part be explained by more severe or complex cases and/or patients with more comorbidities being sent to the CHUV as a university hospital, whereas the CHUV is the reference center for all patients who live in the area, even if their CHD is not extremely complex. However, the difference between rates of readmission according to canton of origin is too stark to be explained by this single factor. It is likely that patients who live far from the CHUV have had less follow-up due to simple lack of availability of specialized care in their area. This highlights the need for specialized CHD consults in peripheral regions.

Study limitations

The main limitation to our study is the small sample size, with few patients undergoing surgery, leading to a low statistical power. Further studies are needed to increase sample size, for example by joining all data from Switzerland.

Conclusion

In a Swiss university hospital, slightly less than one out of ten children with CHD are readmitted within 30 days after the index hospitalization. Distance from hospital, being a non-national and shorter LOS significantly increase the risk of readmission.

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FIGURES

Figure 1: exclusion criteria.

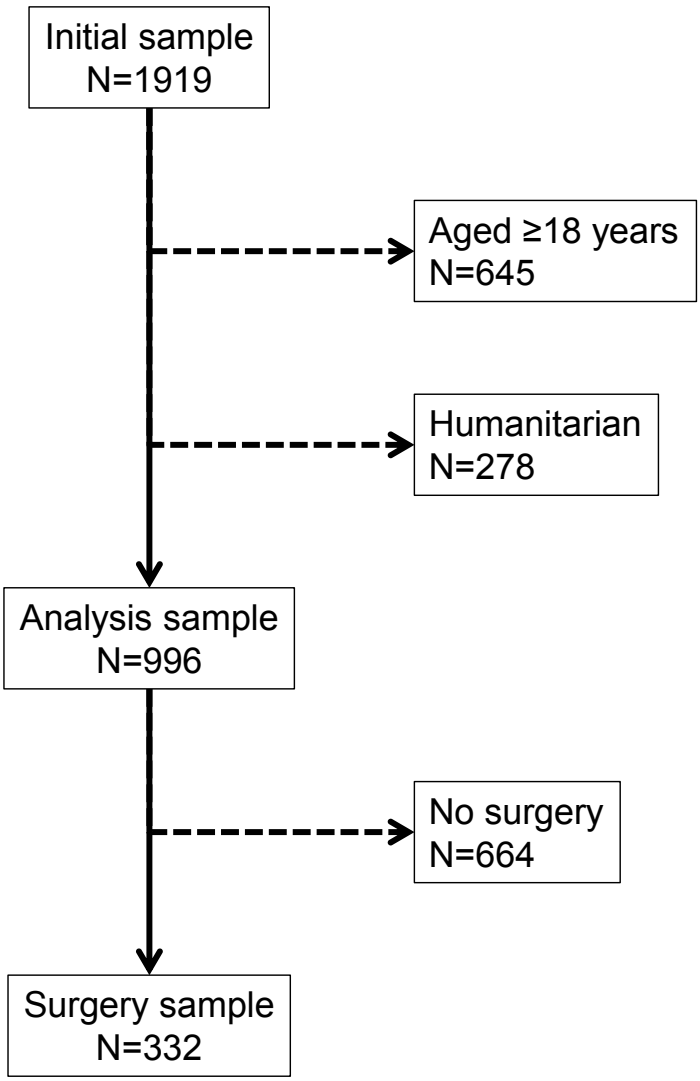
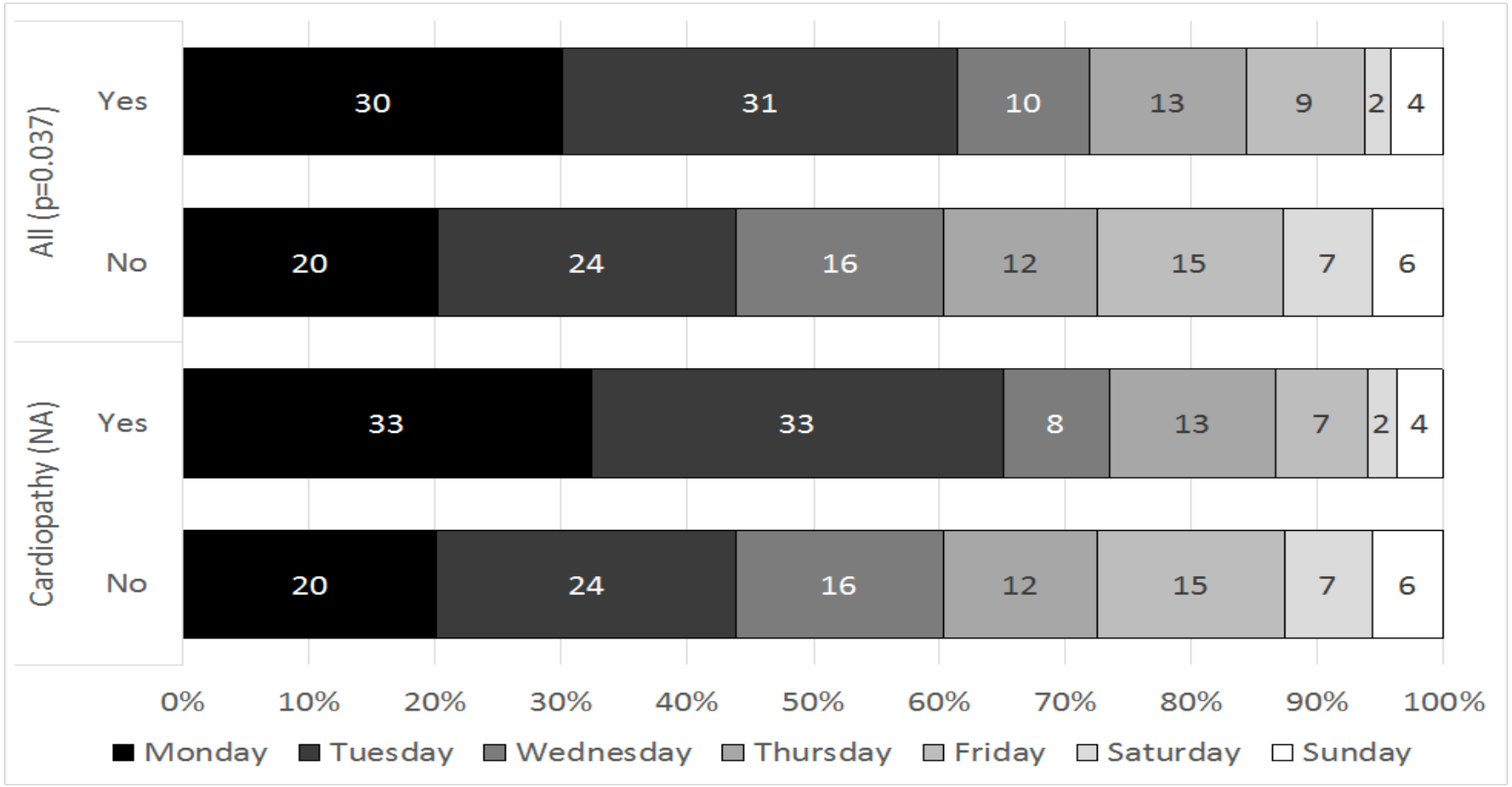


Figure 2: distribution of day of discharge according to readmission at 30 days for cardiopathy or for any cause. Between-group comparisons using Chi-square; NA, not assessable.



TABLES

Table 1: characteristics of the sample, overall and according to surgery.

	All	No surgery	Surgery	P-value
N	996	664	332	
Women (%)	460 (46.2)	312 (47.0)	148 (44.6)	0.472
Swiss nationality (%)	558 (56.0)	378 (56.9)	180 (54.2)	0.416
Age (years)	2.7 ± 4.4	2.2 ± 3.9	3.8 ± 5.0	<0.001
Age groups (%)				<0.001
[0-1[	615 (61.8)	454 (68.4)	161 (48.5)	
[1-18[	381 (38.3)	210 (31.6)	171 (51.5)	
Type of disease §				<0.001
Q20	97 (9.7)	56 (8.4)	41 (12.4)	
Q21	531 (53.3)	380 (57.2)	151 (45.5)	
Q22	55 (5.5)	38 (5.7)	17 (5.1)	
Q23	66 (6.6)	26 (3.9)	40 (12.1)	
Q24	42 (4.2)	33 (5.0)	9 (2.7)	
Q25	205 (20.6)	131 (19.7)	74 (22.3)	
Length of stay (days)	15.1 ± 29.5	12.0 ± 27.9	21.4 ± 31.7	<0.001 §

Results are expressed as mean ± SD or as number of participants (percentage). Comparisons between surgery groups performed by chi-square for categorical values and Student's t-test or Kruskal-Wallis (§) test; p-values are for a two-sided test. § ICD-10 codes: Q20, congenital malformations of cardiac chambers and connections; Q21, congenital malformations of cardiac septa; Q22, congenital malformations of pulmonary and tricuspid valves; Q23, congenital malformations of aortic and mitral valves; Q24, other congenital malformations of heart; Q25, congenital malformations of great arteries.

Table 2: bivariate analysis of the factors associated with readmission at 30 days for cardiopathy or for any cause.

	Cardiopathy			Any cause		
	No	**Yes**	**P-value**	**No**	**Yes**	**P-value**
N	913	83		900	96	
Gender (%)			0.592			0.773
Woman	424 (46.4)	36 (43.4)		417 (46.3)	43 (44.8)	
Man	489 (53.6)	47 (56.6)		483 (53.7)	53 (55.2)	
Age groups (%)			0.087			0.345
[0-1[	571 (62.5)	44 (53.0)		560 (62.2)	55 (57.3)	
[1-18[	342 (37.5)	39 (47.0)		340 (37.8)	41 (42.7)	
Nationality (%)			0.008			0.057
Not Swiss	390 (42.7)	48 (57.8)		387 (43.0)	51 (53.1)	
Swiss	523 (57.3)	35 (42.2)		513 (57.0)	45 (46.9)	
Type of disease §			NA			NA
Q20	90 (9.9)	7 (8.4)		89 (9.9)	8 (8.3)	
Q21	475 (52.0)	56 (67.5)		471 (52.3)	60 (62.5)	
Q22	52 (5.7)	3 (3.6)		51 (5.7)	4 (4.2)	
Q23	62 (6.8)	4 (4.8)		59 (6.6)	7 (7.3)	
Q24	40 (4.4)	2 (2.4)		40 (4.4)	2 (2.1)	
Q25	194 (21.3)	11 (13.3)		190 (21.1)	15 (15.6)	
Canton of origin			0.004			0.034
Vaud	546 (59.8)	42 (50.6)		540 (60.0)	48 (50.0)	
Neighbor ‡	238 (26.1)	18 (21.7)		231 (25.7)	25 (26.0)	
Other	129 (14.1)	23 (27.7)		129 (14.3)	23 (24.0)	
Surgery (%)			0.168			0.494
No	603 (66.1)	61 (73.5)		597 (66.3)	67 (69.8)	
Yes	310 (34)	22 (26.5)		303 (33.7)	29 (30.2)	
LOS>14 days (%)			0.005			0.055
No	677 (74.2)	73 (88.0)		670 (74.4)	80 (83.3)	
Yes	236 (25.9)	10 (12.0)		230 (25.6)	16 (16.7)	

Results are expressed as number of participants and (column percentage). Statistical analysis by chi-square; p-values are for a two-sided test. § ICD-10 codes: Q20, congenital malformations of cardiac

chambers and connections; Q21, congenital malformations of cardiac septa; Q22, congenital malformations of pulmonary and tricuspid valves; Q23, congenital malformations of aortic and mitral valves; Q24, other congenital malformations of heart; Q25, congenital malformations of great arteries. ‡, Fribourg, Geneva, Neuchâtel and Valais. NA, not assessable.

Table 3: bivariate analysis of the factors associated with readmission at 30 days for cardiopathy or for any cause, only patients who underwent surgery

	Cardiopathy			Any cause		
	No	**Yes**	**P-value**	**No**	**Yes**	**P-value**
N	310	22		303	29	
Gender (%)			0.932			0.977
Woman	138 (44.5)	10 (45.5)		135 (44.6)	13 (44.8)	
Man	172 (55.5)	12 (54.6)		168 (55.5)	16 (55.2)	
Age groups (%)			0.768			0.716
[0-1[	151 (48.7)	10 (45.5)		146 (48.2)	15 (51.7)	
[1-18[	159 (51.3)	12 (54.6)		157 (51.8)	14 (48.3)	
Nationality (%)			0.393			0.914
Not Swiss	140 (45.2)	12 (54.6)		139 (45.9)	13 (44.8)	
Swiss	170 (54.8)	10 (45.5)		164 (54.1)	16 (55.2)	
Type of disease §			NA			NA
Q20	40 (12.9)	1 (4.6)		39 (12.9)	2 (6.9)	
Q21	135 (43.6)	16 (72.7)		133 (43.9)	18 (62.1)	
Q22	16 (5.2)	1 (4.6)		16 (5.3)	1 (3.5)	
Q23	39 (12.6)	1 (4.6)		37 (12.2)	3 (10.3)	
Q24	9 (2.9)	0 (0)		9 (3.0)	0 (0)	
Q25	71 (22.9)	3 (13.6)		69 (22.8)	5 (17.2)	
Canton of origin			0.746			0.939
Vaud	147 (47.4)	10 (45.5)		144 (47.5)	13 (44.8)	
Neighbor ‡	99 (31.9)	6 (27.3)		95 (31.4)	10 (34.5)	
Other	64 (20.7)	6 (27.3)		64 (21.1)	6 (20.7)	
LOS>14 days (%)			0.150			0.483
No	192 (61.9)	17 (77.3)		189 (62.4)	20 (69.0)	
Yes	118 (38.1)	5 (22.7)		114 (37.6)	9 (31.0)	

Results are expressed as number of participants and (column percentage). Statistical analysis by chi-square; p-values are for a two-sided test. § ICD-10 codes: Q20, congenital malformations of cardiac chambers and connections; Q21, congenital malformations of cardiac septa; Q22, congenital malformations of pulmonary and tricuspid valves; Q23, congenital malformations of aortic and mitral

valves; Q24, other congenital malformations of heart; Q25, congenital malformations of great arteries. ‡, Fribourg, Geneva, Neuchâtel and Valais. NA, not assessable.

SUPPLEMENTARY ONLINE TABLES

Supplementary table 1: international classification of diseases (ICD-10) codes used to define congenital heart disease.

ICD-10 code	Designation
Q20	Congenital malformations of cardiac chambers and connections
Q21	Congenital malformations of cardiac septa
Q22	Congenital malformations of pulmonary and tricuspid valves
Q23	Congenital malformations of aortic and mitral valves
Q24	Other congenital malformations of heart
Q25	Congenital malformations of great arteries

Supplemental table 2: characteristics of non-humanitarian and humanitarian patients.

	Non-humanitarian	Humanitarian	P-value
N	996	278	
Women (%)	460 (46.2)	108 (38.9)	0.03
Age (years)	2.7 ± 4.4	5.2 ± 3.7	<0.001
Age groups (%)			<0.001
[0-1[	615 (61.8)	16 (5.8)	
[1+	381 (38.3)	262 (94.2)	
Type of disease §			<0.001
Q20	97 (9.7)	29 (10.4)	
Q21	531 (53.3)	195 (70.1)	
Q22	55 (5.5)	9 (3.2)	
Q23	66 (6.6)	12 (4.3)	
Q24	42 (4.2)	11 (4.0)	
Q25	205 (20.6)	22 (7.9)	

Results are expressed as mean ± SD or as number of participants (percentage). Comparisons between groups performed by chi-square or Student's t-test; p-values are for a two-sided test. § ICD-10 codes: Q20, congenital malformations of cardiac chambers and connections; Q21, congenital malformations of cardiac septa; Q22, congenital malformations of pulmonary and tricuspid valves; Q23, congenital malformations of aortic and mitral valves; Q24, other congenital malformations of heart; Q25, congenital malformations of great arteries.